



HOUSE OF LORDS

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Inquiry on

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Witnesses: Martin Wolf, Oliver Quinlan, and Jessica Bland

USE OF THE TRANSCRIPT

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Members present

Baroness Morgan of Huyton (Chairman)
 Lord Aberdare
 Earl of Courtown
 Baroness Garden of Frognal
 Lord Giddens
 Lord Haskel
 Lord Holmes of Richmond
 Lord Janvrin
 Lord Kirkwood of Kirkhope
 Baroness O’Cathain

Examination of Witnesses

Martin Wolf, Chief Economics Commentator, Financial Times, **Oliver Quinlan**, Programme Manager, Digital Education, Nesta, and **Jessica Bland**, Senior Researcher in Technology Futures, Nesta

The Chairman: Welcome. Thank you very much indeed for agreeing to join us today and give evidence. This is our first public meeting of this new Committee, so we are grateful that you could join us. This is obviously a formal evidence session of the Committee and a full shorthand note will be taken. This will be put on the public record in printed form and on the parliamentary website. You have a list of interests of the Committee, which is there in front of you, but because this is the first meeting each of us who has things listed will say that because we have to have it on the public record. You will be sent a copy of the transcript and you will be able to revise it in terms of any minor errors that have been made. This session is on the record. It is being audio broadcast live—not webcast on this occasion, which is a bit sad, but it will be subsequently accessible on the parliamentary website. Witnesses and Members are asked to speak up clearly partly because there is some noise outside but also just to make sure we get an accurate record. I think that is all in terms of the housekeeping. First of all, would you like to make some brief opening remarks before we get into the question session? Professor Wolf?

Martin Wolf: I had not really intended to and I must say I would rather get into questions.

The Chairman: Go into questions, fine.

Martin Wolf: I am very good at making hour-long speeches but I do not think you will want to listen to it.

The Chairman: That is absolutely fine. That is a very good start.

Jessica Bland: I would agree with that. I have come with answers to questions in mind.

The Chairman: That is fine. That is very helpful.

Oliver Quinlan: Yes.

The Chairman: I should also say that obviously you do not all need to answer every question, particularly the two colleagues from Nesta. It may well be that you will alternate because otherwise we will get a lot of Nesta and not as much of Mr Wolf.

Jessica Bland: That is why we are both here.

Q1 The Chairman: Thank you very much. I will start with the first question. I will just put my interests on the record—I will whip through them—which may be relevant: non-executive director of Carphone Warehouse, Infinis plc and on the advisory committee of Virgin Group Holdings. I am Chair of Ofsted, Chair of Future Leaders, which is a head teachers' charity, Teaching Leaders board member. I am on King's College Council and I am adviser to ARK, which run schools in the UK. That is just to put that on the record.

Can we start by a big overarching question to try to get the big landscape view, which is what we are particularly interested to hear from you today? Can you describe for us what you see as the future big technology innovations and the trends and how, in a broad sense, they will impact on the UK's economic future? If you can help us by painting that sort of big picture at the start of the Committee, that would be very helpful. Mr Wolf?

Martin Wolf: I think I will make three points. First, I think it is very helpful, incredibly important, if we are thinking about the future, about which we know rather little, to think about the past and what we have already gone through, because we have had 200 years at least—we can go further back, but 200 years at least—of quite rapid technological progress in which our lives collectively have been utterly and completely transformed. I am a Luddite in these matters—sorry, I should not use that word; “antediluvian” perhaps—and I think we are in a period of relatively slow technological change. Everybody thinks, except people who I think really understand economic history, that we are living in a period of unbelievably rapid technological change, but if we think about the process of the last few centuries and particularly the period since between about 1860 and 1940, and we look at the range of changes that occurred in the economy over that period in the western world—electricity, the internal combustion engine, aircraft, the chemical industry, motor vehicles, radio, telephone; I could go on—and everything that electricity brought with it, I think the consequent transformation of our economy, ways of work, social patterns and so forth was more profound than what we are going through. We can discuss this in more detail, but I think it is very important not to think that we are experiencing something in any way utterly unprecedented. It is different. It is always different but these are not utterly unprecedented sorts of challenges, and people previously were also very worried about the consequences of all this.

The second point is that we clearly are in the process of a revolutionary transformation in the interaction of computing and communications. That is the area of most obvious transformation at the moment. I am not going to go into biotechnology at all unless you want to discuss it. I do not consider myself at all knowledgeable there, but obviously the potential there is also very profound. I think it is clear that the integration of computing and telecommunications is a revolution that has been going on now for about 40 years. It is not a new one, but it is continuing and it is rapid. There is a dispute over this but some people argue that we are on the verge of genuine artificial intelligence, which is clearly a transforming moment if true. But even as it is, it is important to remember that computers have already done incredibly big things to our labour-market services. I was discussing this

before I came in. To take one example, they got rid of all the clerks we used to have. It was a huge number of jobs. So that is the second thing.

The third thing is that by its nature the future is unknowable. There are very different aspects of the transformation but if you are particularly interested in labour-market effects of all this, the really important aspect of that to my mind is uneven impacts. If you could imagine a technological revolution that made all of us more productive to exactly the same degree, it would create relatively small challenges. We would all just be much better off. But it is the extent to which that is not the case that seems to me to create enormous challenges for pattern of jobs and the pattern of incomes. In this case there are profound possible effects.

The Chairman: Thank you. Any Nesta comments?

Jessica Bland: I do not want to be drawn into an argument about whether it is slow or fast innovation at the moment compared to the past, but I think the point about the computing and communication revolution is well made. Certainly from our recent research, I would point to almost three stages we are seeing of particular digital revolutions that are happening one after the other to some extent. Many people talk about the need for coding skills among our current secondary school students and Oliver can speak much more to the Year of Code and to those kinds of digital-making skills, and in some ways that is backfilling for what we see as a shortage of skills in programming at the moment.

There are two things in my research at Nesta and my colleagues' research that we are seeing the beginnings of that are probably worth mentioning at the beginning of today. The first is around data analysts. These are people who have—to use a technical term—machine-learning skills or large-data-set analysis skills and they are partnering those with statistical skills. These are in a piece of work that is coming out tomorrow called *Model Workers* from Nesta. It is something that we see great demand for, not just in what might be called big data companies but across several sectors, from pharmaceuticals to the creative industries. It is quite a specific set of skills they are looking for. What was interesting in the interviews behind that research was that it was that this was about not just the ability to bring together those disciplines but also the ability to have understanding of the domain you are working in—not just to be the data analyst in the ivory tower in the corner of a business but to bring those skills out into business strategy that those particular companies feel that they are missing at the moment. There was almost a repetition of some of the arguments we had around programming perhaps 10 years ago that we are now seeing around data analysts.

Finally from my own particular area of interest, I think where we are seeing the diffusion of low-powered computing—the internet of things or the smart home or whatever comes to your mind—that implies again another generation of particular kinds of digital skills: those people who can manage data exchange over whole urban structures. I think particularly of one small initiative in London called OpenSensors.io where they are producing new kinds of engines for sharing data between multiple devices. So it is a kind of many-to-many data-sharing problem rather than a one to one, and we see very few people with those skills. OpenSensors.io is a team of I think about three at the moment and the demand for them is much, much greater. So there does feel to be a generational thing going on here and you can see somewhere into the future where that might go.

Q2 The Chairman: To what extent should we as a Committee be nervous about the changes that are coming, be positive about the changes that are coming or be both?

Jessica Bland: Perhaps Oliver can talk about the present but I feel the thing that frustrates me about the changes that are coming is that if we have seen a similar pattern of undersupply of particular skills in the past, why are we not creating the systems that can be aware of what is coming up rather than constantly backfilling for what we see is coming along? We will come on later to specific recommendations but I am not so nervous of it. It is more that if we can at least see the green shoots of these things we should have a more adaptive system to deal with them.

The Chairman: Do you want to add anything?

Oliver Quinlan: I would add that perhaps my own angle is very much from education. My background is as a primary school teacher and a teacher educator in this area. We have a lot of discourse about specific skills, such as programming skills, computer science and perhaps some of these more emerging skills that Jessica has just alluded to, but I have a nervousness about the general population's understanding of the underlying mechanics of technologies and where those things might be going. I think some of that is very technical and relies on technical understanding; some of it is more societal in terms of seeing how people entrust their data to large corporations and what the longer-term implications of all of us opting into something, often out of ignorance, may be. So those would be my areas.

Martin Wolf: I am inclined to think that nervousness is pointless. It is almost like getting nervous about the weather. We are seeing some very important areas of innovation. In the economists' jargon these are general purpose technologies, if any are. They are going to affect everything. They are or are going to be part of everything and they are going to be introduced in every possible way. We are going to go on riding this wave one would imagine for quite a long time, so it is a question of taking advantage of it and managing those problems that arise, so one has to take a pretty forward-looking view of it.

The second point I would make, and we can have this debate, is that I am not sure how far we are going to be able—I am generally sceptical about this—to identify needed labour-market skills over the time horizon of the education system at least. We have a problem that it takes a very long time to create an adult human being and one is an adult human being for a very long time, in relationship to these changes. So the whole period from beginning to educate the child to retirement—and that is perhaps 70 or 80 years for all we know—and trying to guess now what will be needed over 70 or 80 years as a result of these changes seems to me to be basically hopeless.

There are necessary skills that we clearly need if people are going to have any capacity to cope with the sort of world that is coming up, but some of these are quite complicated because—and this is my third point—I think it is very important to make the following distinctions. There are implications for us as producers of these services and technologies, broadly defined. My own guess is the number of people who are producers in this area is going to be a relatively small part of our labour force—a very important part but a relatively small part. Then there are an immense number of users. Some of them will be relatively well-informed users and some possibly very highly paid users who have no idea of how it works and do not really have to. I suspect the capacity to use them is going to be more important than to be producers. I am not denying that.

The final thing—incredibly important—is that there are all the sectors that are likely to grow as incomes rise as a by-product of the productivity generation in this sector. I think this is incredibly important to understand. My own view that it is pretty clear—it is almost inconceivable it will not be true—that almost everybody 20 years from now essentially will be in a service activity. We are almost there anyway. A lot of these service activities will have nothing to do with IT and digital, per se. They will be the things we can afford as we get richer: caring for one another, entertaining one another and all the rest of it. So when you are thinking about the labour-market effects of productivity-enhancing change, you have to think of the sectors into which labour will be released. Historically, it is the low-productivity-growth sectors that are highly demanded as we get richer and that have generated all the employment. By definition, those are the sectors furthest away from the area of technological change, not closest to it.

If you start thinking about the areas where we have not seen massive reductions in the numbers of people working—school teachers, for example, or people in the health system—it is because these are the least easy things to display. It can be complemented by these—and they must be, that is very important—but if you are thinking about the ultimate implications for the labour market, and I know this is on digital skills, they are: do not just look at the spotlight that you are looking at because I believe the activity will be much more likely to be somewhere else.

The Chairman: That is helpful.

Q3 Baroness O'Cathain: Very briefly, following the scenario painted by Jessica Bland, where you have these new green shoots that are incredible and mind-blowing, very few people are going to be involved in them or at least are involved in them at the moment. Obviously that will grow. But the greater the development of this technology, the greater the growth in people not being able to cope with it—and talking about the demographics of this country, the digital divide will widen and widen. I know this question is about the labour market, but the labour market of course will then have to cope with the situation at the top end of people who are living longer and being more and more isolated from modern technology. What should we do to ensure that digital skills and at least keeping abreast of the technology is No. 1 in every young person's mind?

Jessica Bland: Is there an answer from today's curriculum at all, about people who will be users?

Baroness O'Cathain: Who will be left out?

Oliver Quinlan: Yes, there are. I totally agree with the point that most people will be users of this kind of technology and not need to understand it in the same way someone many years ago may have needed to understand the ins and outs of how their car worked to be able to fix it. I do not think that is a comparable situation. But I think a broad understanding of the underlying concepts behind things is important. In this case the computer science elements of the new national curriculum are very welcome in that area, because they are focused on the fundamental concepts of computation rather than a specific technology. The various parties who were involved in putting that together were very right to leave that in that type of form, because many of these underlying concepts have developed but not fundamentally shifted since the early days of computing; they have continued to develop. So I think that

intellectual approach and looking at young people understanding the discipline of computer science and the broad—

The Chairman: So only in the brain in a sense.

Oliver Quinlan: Yes. A lot of people in education are talking about the concept of computational thinking at the moment being at the core of this. I think that is far more important and has a much longer life than talking about young people learning to write Python code.

The Chairman: Yes. We need to keep it tight so we can get through the questions.

Martin Wolf: An argument that technologists would make is that the essence of what has happened is that as the machines get smarter using them becomes easier. In some obvious sense that is true. I am old enough to have used pretty well the first PC ever, the Apple G2. It was really, really hard and it is now really, really easy. So if we believe in the artificial intelligence model or anything like that, we are going to have computers that will talk to you. You will talk to them. You will use natural language. They will clean your house, or whatever you want them to do, and the digital divide will simply melt away. It will be just like dealing with another human being.

I do not believe that model, but that is what one is being told and clearly it is already true. If you think of a smartphone, it is a pretty simple machine and I do not believe—I would have to say that, would I not—that just because one is getting on a little bit that one cannot understand how to work them.

Q4 Lord Haskel: I would add that when I started we had an Acorn computer and on the screen you had an “A” with a little accent but then you were on your own. What you have been describing to us, whether we are nervous about it or not, is going to happen is what most people call a knowledge-driven economy. Can you tell us what are the main challenges for economic growth in a knowledge-driven economy? How do we need to adapt to it so that we can make our living in such a world and be competitive?

Jessica Bland: That is a very big question. But one thing I did want to talk about in talking about this divide—or not—was the effect on not just the creative industries but the creative economy as a whole, including people who are designers in engineering companies, who have the creative jobs in a classically not-creative sector. Nesta did some work on that last year and estimated that about 2.5 million people are working in that area. It has been growing at four times the rate of the other bits of the workforce in recent years. A lot of those people are creatively using technology. I think there is a nice parallel with computing languages here. You might say that they are using extremely high-level languages, so they are not using C, which is the basic one, but they might be using R or Python and in fact some of the visualisation languages that sit on top of that. So there are new nexuses that I think complicate this landscape that we are talking about. Concentrating on some of those occupations and those jobs, where we are already seeing growth, would be my emphasis.

Martin Wolf: This is sort of a frightening question because it amounts to: what is the economic future? I personally—again this probably shows my prejudice—do not find the knowledge-driven-economy notion terribly helpful because the economy is knowledge-driven, period. There is nothing else ultimately. Even before the Industrial Revolution, farming required a lot of knowledge—in fact, an immense amount of knowledge, most of which, of course, we have now lost. The same has been true with each development. So it

seems to me that understanding what is going on and how to use it remains the principal challenge. I think what changes is what you have to know about and how to use particular technology.

Obviously what is important about this—and this is the sense in which I can understand this idea—is that the core technological revolution of our time is itself about the application, development and distribution of knowledge and that is the core activity. In that sense I can understand it. But it has always been embodied in other things and will continue predominantly to be embodied in other things. To take an example, the motorcar industry is going to be and is being transformed by these processes. It is still the motorcar industry. So I am not sure we should get hung up on this.

The second point is that this is part of a broader question. If you think about the world we live in at the moment, there are several very large trends coming together. This is one of them, namely, a technological revolution, which changes the economy. The other pretty obviously is globalisation. They are interacting. It is difficult to think about just one of them without thinking about the collection of things.

The third point I would make—and this is the last, because there are so many issues here—is that right at the moment it is pretty clear that we have a problem in generating rising living standards in this country. We have had an exceptionally long period of what appears to be productivity stagnation—really exceptionally long and it is still something of a puzzle. But this suggests that something is not working terribly well. My own view on this is that we have to think about what our particular areas of comparative advantage are likely to be and what sort of skills we are going to need to support those. I think in our case they are going to be overwhelmingly in the use of these technologies. We are not going to go back into mass manufacturing as a fundamental source of income generation or employment—that is not where we are going to go. It is going to be services and the sort of skills we are talking about is part of that. As I said, a lot of the things that are likely to develop and be important for our economic future could well be precisely the things that are least affected by these technologies. We cannot be at all confident about it. But the main point I would make is that I feel that beyond the relatively short horizon, perhaps five to 10 years, if we are thinking about the planning of education and skills, what the world economy is going to look like, in terms of where people are going to be employed and what jobs will grow, is becoming very difficult to predict.

Lord Haskel: But meanwhile in this globalised economy we have to earn our living. So how can we support the inventiveness, the adaptation and the diffusion of all this new technology to generate growth and help us earn our living in the modern world?

Martin Wolf: This amounts to answering the question: what is your growth strategy for the country? How many hours do you have?

The Chairman: You have two minutes, Martin.

Martin Wolf: I think the broader answers are reasonably clear. You need an economy that—because this is trial and error stuff—has a lot of entrepreneurial flexibility and adaptation; you need to produce a labour force that is sufficiently broadly skilled and educated to be extremely flexible and be able to work in many different ways. I think the core of that is fundamental numeracy and literacy and a lot of specialised skills. You need to create really productive interfaces between the parts of our system that generate knowledge and

information, particularly but not exclusively universities and the productive system. We happen to have an extraordinarily successful higher education and research system by the standards of most comparable countries and we are going to have to live on that to a very significant degree. We also have an incredibly successful creative industry, which again is something one might be able to support. But if you are asking me to produce an economic plan for Britain for the next 20 or 30 years I am afraid, with great respect, I would have to decline.

The Chairman: Lord Janvrin, do you want to pick up on that?

Q5 Lord Janvrin: Perhaps I could come in on that last point, which is about innovation and creativity, particularly talking about digital skills. As a panel do you have any advice on how we should continue to nurture creativity innovation, particularly in this area? Are there things that we should be thinking about that we are not doing in the financial sector, in education and so on, in encouraging innovation and creativity? That seems to lie at the core of what you were saying, Martin.

Martin Wolf: Why do you not go on this first?

Oliver Quinlan: Okay. From an education perspective I think what we have been talking about in terms of being agile is important. If we are looking at that particularly in a digital area, one of the areas that I think is a potential concern within schools is how digital skills are linked in with different subjects across the curriculum. I think there is a lot of discussion to be had moving on from the computer science in the curriculum, where we have had a lot of change recently and teachers need to be getting to grips with that—there is a lot of work to be done in upskilling. But there is another section about digital skills within different subjects and, as Jessica said, particularly in areas like science there is a huge influence of not just using the kinds of skills that were previously taught in the ICT curriculum but actually computational skills, visualisation and those kinds of areas. That is just one subject that is an example. I think an area to look at is the opportunities for young people to see those links across different subjects, the opportunities for teachers to be able to be up to date themselves with how those developments affect their subjects as well.

Jessica Bland: Yes. To give one example, not from the secondary sector but from the higher education sector, if you look at some of the art and design schools in the UK they are now increasingly teaching digital skills in some of these ways. They have bespoke courses for people who have not done maths for, well, in some cases six or seven years. They are thinking quite carefully about how to make those courses bespoke to those people, to not lose them along the way. Even if people have not had this experience at school level there are opportunities further on in the education system to bring those things back together, often with a stronger hook. If you are someone moving into that as an occupation you want to be at the cutting edge when you graduate.

Martin Wolf: I would say that to me this is just unbelievably difficult. What people need to know to be creative and how you produce people who are creative is scary—just scary. I think having an environment that encourages it and in which it is believed to be valuable is very important and I believe, as I said, that having a good all-round basic education is very important. I was thinking when you were saying this—I was just reminding myself—that to my knowledge Paul McCartney never learnt how to read or write music. It did not seem to

do him too much harm. It suggests that defining what it is to be creative and what skills you need is quite important.

I am a bit concerned about the digital skills concept. My colleagues might be able to explain this, but to me most of the skills we are talking about are quite generic and they are not digital. Digital obviously refers to the way information is encoded within the system as developed by the great computer geniuses from the past, von Neumann and Turing. You do not have to understand that stuff. Even at a philosophical level you do not, I think. You do not even need to understand how the internet works to use it, and I think the number of people who really understand how the internet works is incredibly small, but that does not matter because they do. As I said before, the number of people who are going to end up doing that sort of engineering will be very small. So I tend to think that in the end almost a characteristic of a general purpose technology—and I think it is the most general purpose technology imaginable, because it affects human skills—is that it changes everything. These are tools and the question is how the tools are going to be used. They are not necessarily going to be used by people who know how the tools work, so it is building on what we already have but even more so.

Q6 Earl of Courtown: In filling in some of the details of technology landscape, one has to look at the regional differences throughout the United Kingdom. You hear about the M4 corridor or Tech Valley. Are there other areas that are particularly lacking? Are there other areas that are particularly concentrating on these issues? Also is it really important where it is in the UK?

Martin Wolf: Do you want to talk about the geographical distribution?

Jessica Bland: Not particularly, but I am happy to—

The Chairman: If you want to go away and think about any of these questions, we are very happy to receive further evidence from you in writing afterwards.

Jessica Bland: I did not want to talk about particular regions, but there is some evidence of localised effects. I am thinking particularly of the *Model Workers* report, which comes out tomorrow, so unfortunately I cannot bring it with me today—I will send it through. You see particularly good spillover when you have data. For example, with companies that are very good at data analytics you see positive spillovers locally. This is not necessarily about clustering but certainly there is a sense of creating a critical mass in particular areas. There may be a role for the local enterprise partnerships in this area but I am not exactly clear what that role would be.

Martin Wolf: It is clear that producers in these broad areas cluster dramatically. This is so obvious. It is quite interesting. I regard it as almost a joke that if you think of the two industries that are most changed by this they are the IT sector itself and the finance sector. Therefore if you believe that the essence of almost infinite bandwidth communications is that it does not matter where you are, the surprise is that it clearly matters dramatically, because they all on top of one another, even if they have to live in congested circumstances. The famous points made by Paul Krugman and Tony Venables about the economics of clustering seem to overwhelm the industry that in theory is working against them. That is very, very interesting. Being on top of one another is clearly crucial; being close to universities seems to be crucial. I stressed that before. Essentially you have the Boston cluster and you have the San Francisco cluster and that is because of the universities. I have

long believed that in the long term we are going to find that our universities are the most important regional development institutions in our country. Now, that is problematic too, because of the nature of the people whom they are likely to promote, but if you are thinking about the sector itself and what it is producing, then that is very important.

If you think about the creative industries more broadly, people cluster there too because they like to be close to people who have the complementary skills and who they want to talk to. Amenities are very important to encourage people to go and live in places. I think we are in a world where clustering happens and since the primary raw material is infinite in potential supply—it is not like you have to be near a gold seam if you are going to do gold mining or near a port if you are going to ship lots of steel—that does not matter here. So the clusters become incredibly powerfully self-reinforcing and it is pretty obvious in the UK where they are.

Q7 The Chairman: Can I just ask a supplementary on that? Is there any way that that could be spread proactively? You said that a successful university is almost a starting point. So how can that be taken to more disadvantaged areas of the UK?

Martin Wolf: Well, you cannot just move the whole thing because the way it affects the local economy is very complicated—second and third effects, more tax revenue, more income, more spending, which might generate completely different jobs—but I think you have to build on institutions that exist and consciously support them. So if the British Government were to say, “We are going to make a rather big effort to ensure that relevant scientific and technological research activities and their interface with business do not all end up in the Oxbridge-London triangle”, that would be a perfectly reasonable thing for them to think about. In fact, I know they do think about it. Fortunately, we have absolutely first-rate universities across the country so we can build upon that. I am not just focusing on that—it is just something I know about—but I think that would be the sort of way to think about it.

Our attempt to start real development from scratch by just plonking down a factory somewhere, I do not think that works.

Q8 Lord Holmes of Richmond: From the regional I would like to take us to the global perspective and get your thoughts on how you think the UK shapes up compared with other economies, and what some of the other nations who are ahead of us are doing that we might consider doing in this area.

The Chairman: Who wants to kick off with that?

Jessica Bland: From a schools perspective, there is a league table aspect that might be worth mentioning.

The Chairman: Do not worry, if you do not have anything go away and think about it and you can always send us some stuff—that is fine.

Martin Wolf: This is very difficult because I am really not an expert here. Again, we are talking about production, innovation and use, a lot of it quite remote so if the musical industry or the design industry or the publishing industry uses these technologies they might be anywhere. I would have thought that in terms of production in these sectors we are reasonably well positioned against the other large European countries. Clearly in aggregate—it is inevitable—we are way behind the US, probably on a per capita basis too. The most successful countries in my view in the production of IT services and technology

interestingly are a range of quite small countries—basically the Scandinavian countries and Israel. There has been a remarkable amount of ongoing continuing innovation in this sector and those are the countries and the parts of the US that I look to. They are the only places it seems to me obvious that on a per head basis are doing better. What are they doing in northern California and Boston? Well, education again is crucial and links with business, including big businesses. Think of the role of Ericsson, for example, and earlier Nokia in Finland. In Israel of course the defence establishment plays a very big role in training people. My wife, who is interested in these areas, wrote once that the most important training institution for high-tech skills in this country is the Ministry of Defence. These are quite surprising places. We could think more actively about what the lessons from these remarkably successful small economies have been and whether there is something we can acquire. I would not have thought France, even Germany—although it has incredible strengths elsewhere that we cannot now replicate—and certainly not Italy; those are not the countries I would look at. I would go to these other places. I could talk about it a bit more but I would not regard myself as sufficient of an expert to contribute much. Get some experts from Sweden or Finland, or Israel.

The Chairman: Thank you, that is very helpful. Lord Giddens.

Q9 Lord Giddens: First of all, I have to declare an interest. I am the patron of Keeping in Touch, which is an organisation that brings information technology to people with dementia in care homes using simplified IT technology.

We have worked through a lot of the questions that are set out here as they are set out so I wonder if I could just make a couple of comments about what Martin said at the very beginning. I think the case for the opposite can be argued forcefully, as someone who has spent quite a lot of my life looking at the history of technologies—there has probably never been a period in human history where the pace of change has been so fast, so global. If you look at the advent of the internet, it is only about 20 years old and it is a truly global phenomenon. Then to me you have another line of other technologies stacked up where, as you say, we do not know the impact. You could make a case for saying some of them look pretty fundamental and pretty revolutionary.

I wonder if Nesta could comment on one aspect of that because you have produced this interesting study of robotics. Are you able to comment on that study? I am particularly interested in what you called the “Cambrian explosion” of second-generation robots that will not look at all like current robots. Robots are doing many, many things already—on the moon and under the sea and so on—but you say that second generation robotics will be bio-robotics, wearable robotics, all sorts of things that we do not normally think of as robotics. You seem to be arguing in the book that this is going to be very transformational so I wondered if I could give you a chance just to elaborate on that.

Jessica Bland: The phrase that you quoted, or at least some version of that, is from Alan Winfield, who is from the Bristol Robotics Lab, and his chapter in our book on the future of the robot economy. His argument is for a second generation or a second wave of robotics that does not look like the humanoid visions of robots that we had or we have had in science fiction for many decades now. It is of a much more pervasive system of intelligence. You will not perhaps have smart systems that interact with you like humans but you have ones that form support infrastructures. So to take the idea of dementia support in the home, there is some great work at Newcastle University looking particularly at helping people around a

kitchen, prompting them on how to make a cup of tea, so that when they fill a cup with water they are reminded to go and put the milk in the top and then to put the milk back in the fridge. So we are seeing robotic intelligence that does not appear to us as the vision of robots that we may have originally thought of but a more, as I said, pervasive form of intelligence. That idea is quite interesting. It leads to maybe a different set of demands on what we are expecting people to be good at in the future, so people who are very good at defining user interfaces rather than people who are good at nuts and bolts engineering may become incredibly important in that wave of robotics compared to what our original vision was.

Lord Giddens: There was a bit about bio-robotics.

Jessica Bland: I am not an expert on bio-robotics but there is some material on wearables and second-skin robotics in the book.

Q10 Lord Giddens: I am going to ask Martin to comment on that. Could you comment also, Martin, on the productivity issue, because you raise that in your interesting article? Some people argue that, as Jeremy Rifkin thought, we are now moving to what he calls a zero-margin economy where many of the traditional measures and values simply do not apply because digital production is going to be quite different—costless mostly—compared with traditional schemas of value.

Martin Wolf: I would make two points, because we have limited time. On the first one, I think it is arguable—I certainly would not disagree with it because it would be pointless—that in terms of communication technology and the associated information processing, what has happened in the last 20 years is faster and more comprehensive than comparable revolutions in the past. So if you think about the move from the cable to the telephone, it took longer, much longer. You can argue—I would disagree with it by the way; I think it is wrong—that this is a bigger effect than that. I think it is almost impossible to exaggerate the effect the cable had but that is not incredibly important. The really important point is all the areas where there are not technological revolutions. I like pointing out that if you look at our transport, technology and energy systems, they are essentially the same as they were 60 years ago—well, 50 years ago. Let us think what happened in the second half of the 19th century and the first half of the 20th: it is just incomparable.

Although this is an incredibly profound thing, I like to think about all the things that are not changing. That fits in with the second point. We are essentially saying that GDP is becoming quite difficult to measure. That is true. By the way, GDP has always been very difficult to measure and it has never been clear what GDP measures, either, but it certainly does not measure welfare. The question here is: has it in some deep sense become more difficult to measure? On that, I think even if you take the Rifkin point that there are a lot of things whose marginal cost is now zero, so they drop out of GDP, that is clearly true. That affects welfare. The question is: is that a much bigger effect than ever before? It is not clear. It might be, but I think we have to have an open mind on the possibility that as a measure of economic success GDP is now just so hopelessly flawed that we have to forget it. I have always felt that any measure that excludes household production is useless anyway. To that extent, of course, productivity really is very difficult to measure. But maybe the more important point is not that productivity is very difficult to measure; maybe the point is that productivity does not mean anything.

I have been thinking about this quite hard because we can still compare it across countries and you can see that some countries, whatever they are measuring, seem to be doing better than we do: the US, for example, recently. Does that matter? I think at the moment I am very agnostic but certainly in terms of GDP, to the extent that we still think it measures anything, we do seem to have a problem. There is a philosophical issue, which I think is a very big one about whether that is something that should concern us.

The Chairman: Thank you very much. We are going to have to move on, I am sorry. Lady O’Cathain and Lord Aberdare, can you ask what you still want to ask on the skills education agenda? We have covered quite a lot of it, I think, in the earlier questions.

Q11 Baroness O’Cathain: I think most of the stuff I was going to ask has been answered already by Mr Wolf. The only thing is the bit in italics: “Employers report a large proportion of young people do not have work-ready skills such as aptitude and attitude of self-management”. Can digital skills help that, I ask: aptitude and attitude of self-management?

The Chairman: It is the social and organisational skills, in a sense, is it not?

Baroness O’Cathain: Indeed, yes, its.

Oliver Quinlan: I would say there are great possibilities there.

Baroness O’Cathain: But there is nothing yet in the curriculum that would help things like that.

Oliver Quinlan: I would say from my teaching experience that that is more about how curriculum is delivered rather than curriculum itself. A curriculum could be constructed around those kinds of skills. The way our curriculum has been constructed is more around the core knowledge of certain disciplines, so therefore those kinds of things, I would say, come down to how something is delivered. There is quite a lot of appetite from the teaching profession for developing those kinds of skills and good case studies could be found, but it would be in delivery rather than in the actual curriculum content.

The Chairman: If you could send us any good case studies, that would be very welcome.

Q12 Lord Aberdare: I should declare my interest as an e-skills UK digital industries ambassador. The one area on skills that seems to me we have not really looked at is the delivery process. How are we going to deliver these skills? We have said it is very hard to identify specific skills that we will need. I think there are two dimensions. First of all, what about the producer skills versus the user skills: do we need to look at those separately? Secondly, are we right to be looking at schools and formal education as the way to deliver these or how can we use the informal system and the fact that most of our grandchildren know how to do things that we certainly cannot? Is that something we can build into the process of developing the kinds of skills and attitudes that we will need for the future, given that we cannot predict what those specifically might be?

Jessica Bland: I think in terms of lifelong learning, of course we can. Particular initiatives like Tech Mums, which allows women who are working part-time or require flexible working, who have their own businesses—I hate the word “digitise”, but there is an aspect of that—to learn to build their own e-commerce solution to what may have been a market stall for a decade. I should declare an interest in that Nesta partly funded Tech Mums through our own

accelerator programme but I think there are little things like that—I would not say they are widespread—where you can see those systems coming into play.

Lord Aberdare: I was hoping we were going to hear something from the learning technologist of the year about this as well.

Oliver Quinlan: There is lots of incredible work being done through informal learning with adults and lifelong learning—I would totally agree with that point—but also with younger people through initiatives again that we have funded with Nesta, such as Code Club and organisations that do things outside of school. The work that Mozilla is doing to allow access to skills is very interesting. From the point of view of a teacher, what I find interesting there is: what are the benefits of these informal learning networks that are allowing some teenagers to make large sums of money with breakthrough apps on the app store? Possibly, the benefit of it is a personalisation and a personalised pathway through something to get to great expertise quite quickly, driven by a strong interest. That is one of the things that traditionally formal education does not necessarily do very well until you get a lot further through the system to the higher education level. So as somebody who would be looking at what are the opportunities for young people, I think that the personalisation aspect that informal learning brings is a very powerful one. It is one that is enabled by technology in very many respects because of the access to a depth of information that technology can allow.

Q13 Lord Kirkwood of Kirkhope: Can I take you back to Martin Wolf's third point about unequal impacts and ask a brief question about inclusion? The early evidence is that there is a genuine concern out there, both in the respect that there are quite stark differences in the participation in the learning part of going into ICT industries and in education between women and men, girls and boys at school. Is that something that we as a Committee, in our recommendations, should be concerned about? Perhaps more generally, on the protective characteristics of age, disability and all of these kind of things, are there obvious things that you can see that we should be thinking about in terms of recommendations to deal with these very important aspects of some of the future changes that we are facing?

Oliver Quinlan: I would agree that divides, particularly the gender divide, are really important areas to look at. I do not think they are necessarily areas with easy answers. Sometimes we see people trying to engage young girls with producing technology by focusing on different ways of manufacturing high-tech jewellery. There is a lot of danger of being incredibly patronising to young women with initiatives like that. It is very important to look at some of the underlying reasons why they might not be deciding or being encouraged to have interests. I think role models are very important. There is a great history in fact of female role models in technology who are not necessarily celebrated through the contemporary representation of what it is to be a producer of technology. I find it difficult to come up with specific recommendations, but I think as an area to explore and try to find the underlying reasons for—and things we can do to remedy it—it is very important.

Q14 The Chairman: We are not going to let you escape without one final question, which we are going to ask all our witnesses, which is: if you could help us come up with one key recommendation within this report, what would it be? Who would like to go first? We could have a joint Nesta one if you wish.

Jessica Bland: We have parts A and B.

The Chairman: Go on, yes, that is good. We like that. There are two of you, so that is all right.

Oliver Quinlan: So from an education angle my recommendation would be to explore how we take forward the three areas of use of digital technology in schools in terms of teacher skills, because I think that is the area that is lacking. Number one, we have a gap with teacher skills in terms of those who are delivering the new computing curriculum. That is something that there has been some funding to address, but there is much less funding than for a subject such as maths, which it could be argued is not a completely new subject in the curriculum. Teachers have largely never even studied it before in many cases, particularly at primary. The other area of the CPD is the subject-specific use of digital technology. The example I gave was of science and how that has been impacted on. If someone has been a teacher for a number of years they may not have experienced how technology is specifically impacting on that subject. That is really important. The other area is how teachers professionally use technology for the best delivery of learning, which is a different and distinct area, in my opinion. The delivery of learning through technology is separate from those other two areas. So my recommendation would be exploring ways that teacher skills in those three areas can be supported, both in terms of the gap that I believe we have at the moment and the continuing engagement with things as they develop in a very fast-moving field.

Martin Wolf: I suppose probably this is going to make your life more difficult. I am going to say something rather different, which is that I think you have to be very careful about emphasising digital skills per se and emphasise—if you think about this in the right context—that it is about fundamental skills and their ability to be used. If you produce people from the educational system who are enthusiastic, flexible, numerate and literate, they are going to do quite well in this world that is going to be very unpredictable. My big worry, which we have not really raised at all, is that these changes will, along with other changes in the economy, reinforce the trends towards massive inequality in our society, which goes way beyond the inclusion points you made. While those are not easy to fix—there are many issues raised there that are way beyond them—part of this clearly is about the sort of educational and continuing education processes we have. That is why I emphasise the point that human capital is an 80-year machine in a way, if you can think about it as that, and you cannot stop the education at the age of 18.

The Chairman: Thank you. That is a really good place to stop. Thank you very much indeed to all of you. That has been really useful. Thank you.